



74VCXH32245

LOW VOLTAGE CMOS 32-BIT BUS TRANSCEIVER (3-STATE) WITH 3.6V TOLERANT AT INPUTS AND OUTPUTS

PRELIMINARY DATA

- 3.6V TOLERANT INPUTS AND OUTPUTS
- HIGH SPEED:
 $t_{PD} = 2.5ns$ (MAX.) at $V_{CC} = 3.0$ to $3.6V$
 $t_{PD} = 3.0ns$ (MAX.) at $V_{CC} = 2.3$ to $2.7V$
- POWER DOWN PROTECTION ON INPUTS AND OUTPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OH}| = I_{OL} = 24mA$ (MIN) at $V_{CC} = 3V$
 $|I_{OH}| = I_{OL} = 18mA$ (MIN) at $V_{CC} = 2.3V$
- OPERATING VOLTAGE RANGE:
 $V_{CC}(OPR) = 1.65V$ to $3.6V$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 32245
- BUS HOLD PROVIDED ON BOTH SIDE
- LATCH-UP PERFORMANCE EXCEEDS 300mA
- ESD PERFORMANCE:
HBM > 2000V (MIL STD 883 method 3015);
MM > 200V



ORDER CODES

| PACKAGE | TRAY | T & R |
|---------|---------------|----------------|
| LFBGA96 | 74VCXH32245LB | 74VCXH32245LBR |

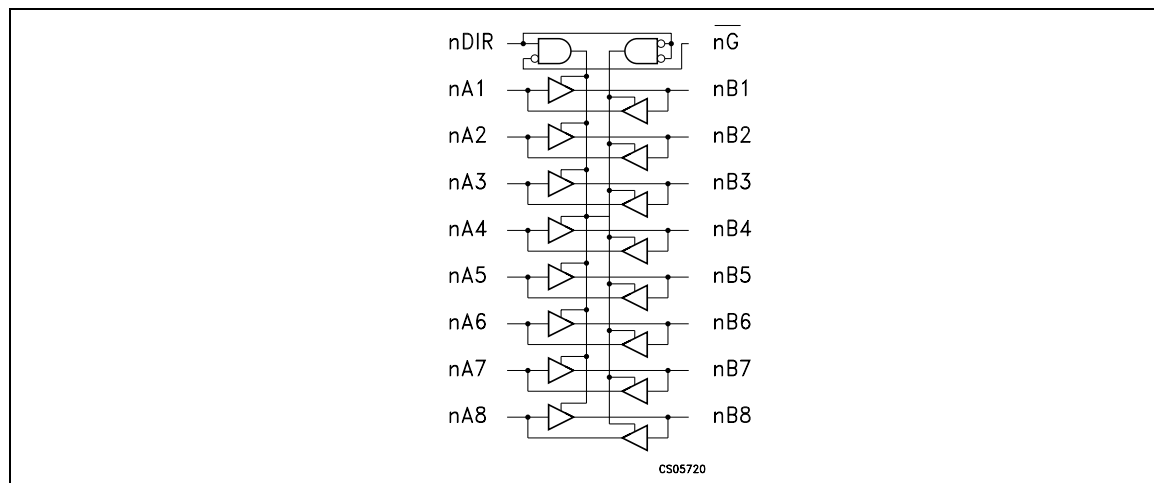
This IC is intended for two-way asynchronous communication between data buses: the direction of data transmission is determined by DIR input. Any nG control output governs four BUS TRANSCEIVER. Output Enable input (nG) tied together gives full 32-bit operation. When nG is LOW, the output are on. When nG is HIGH, the output are in high impedance state so that the buses are effectively isolated. Bus hold on data inputs is provided in order to eliminate the need for external pull-up or pull-down resistor.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

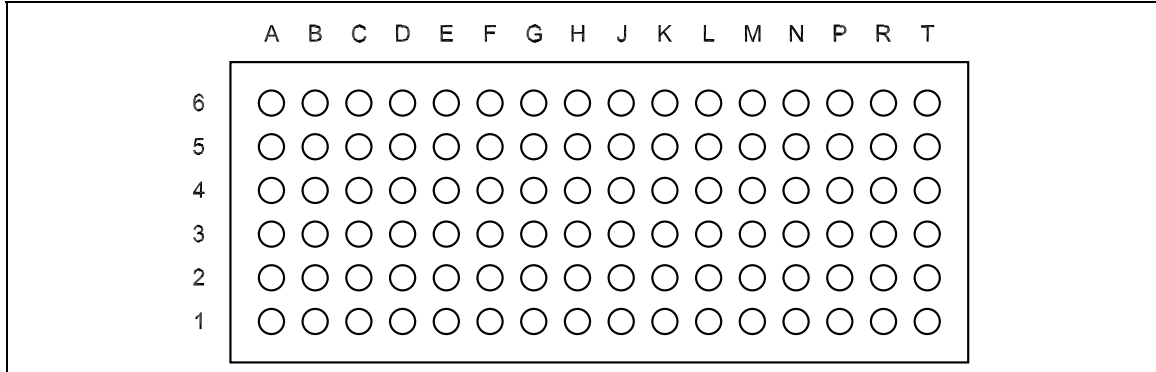
DESCRIPTION

The 74VCXH32245 is a low voltage CMOS QUAD 32-BIT BUS TRANSCEIVER (3-STATE) fabricated with sub-micron silicon gate and five-layer metal wiring C²MOS technology. It is ideal for 1.65 to 3.6 V applications; it can be interfaced to 3.6V signal environment for both inputs and outputs.

LOGIC DIAGRAM



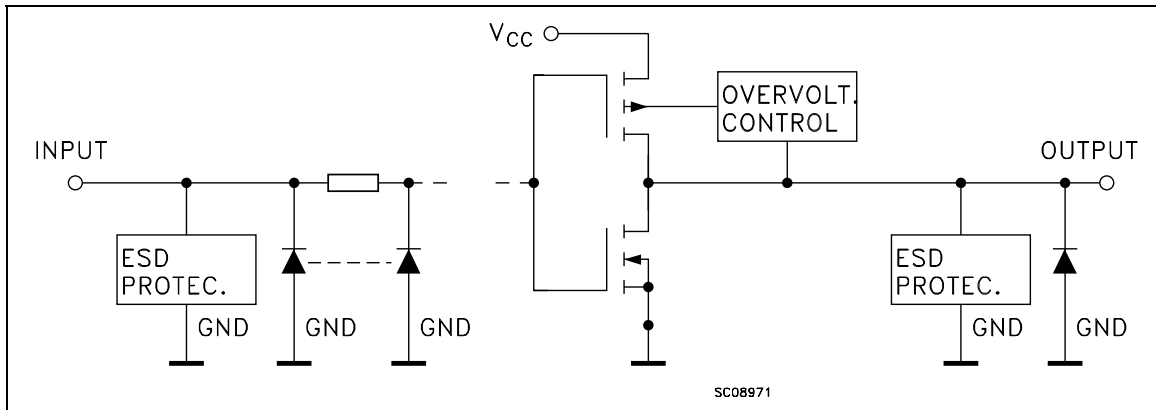
PIN CONNECTION



TERMINAL ASSIGNMENT

| | A | B | C | D | E | F | G | H | J | K | L | M | N | P | R | T |
|---|-----------------|-----|-----------------|-----|-----|-----------------|-----|-----------------|-----------------|-----|-----------------|-----|-----|-----------------|-----|-----------------|
| 6 | 1A2 | 1A4 | 1A6 | 1A8 | 2A2 | 2A4 | 2A6 | 2A7 | 3A2 | 3A4 | 3A6 | 3A8 | 4A2 | 4A4 | 4A6 | 4A7 |
| 5 | 1A1 | 1A3 | 1A5 | 1A7 | 2A1 | 2A3 | 2A5 | 2A8 | 3A1 | 3A3 | 3A5 | 3A7 | 4A1 | 4A3 | 4A5 | 4A8 |
| 4 | $\overline{1G}$ | GND | V _{CC} | GND | GND | V _{CC} | GND | $\overline{2G}$ | $\overline{3G}$ | GND | V _{CC} | GND | GND | V _{CC} | GND | $\overline{4G}$ |
| 3 | 1DIR | GND | V _{CC} | GND | GND | V _{CC} | GND | 2DIR | 3DIR | GND | V _{CC} | GND | GND | V _{CC} | GND | 4DIR |
| 2 | 1B1 | 1B3 | 1B5 | 1B7 | 2B1 | 2B3 | 2B5 | 2B8 | 3B1 | 3B3 | 3B5 | 3B7 | 4B1 | 4B3 | 4B5 | 4B8 |
| 1 | 1B2 | 1B4 | 1B6 | 1B8 | 2B2 | 2B4 | 2B6 | 2B7 | 3B2 | 3B4 | 3B6 | 3B8 | 4B2 | 4B4 | 4B6 | 4B7 |

INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

| SYMBOL | NAME AND FUNCTION |
|-----------------|-------------------------|
| nDIR | Directional Control |
| nA1 to nA8 | Data Inputs/Outputs |
| nB1 to nB8 | Data Inputs/Outputs |
| nG | Output Enable Input |
| GND | Ground (0V) |
| V _{CC} | Positive Supply Voltage |

TRUTH TABLE

| INPUTS | | FUNCTION | | OUTPUT |
|----------------|-----|----------|--------|----------------|
| \overline{G} | DIR | A BUS | B BUS | Y _n |
| L | L | OUTPUT | INPUT | A = B |
| L | H | INPUT | OUTPUT | B = A |
| H | X | Z | Z | Z |

X : Don't Care
Z : High Impedance



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|-----------------------|--|------------------------|-------------|
| V_{CC} | Supply Voltage | -0.5 to +4.6 | V |
| V_I | DC Input Voltage | -0.5 to +4.6 | V |
| V_O | DC Output Voltage ($V_{CC} = 0V$) | -0.5 to +4.6 | V |
| V_O | DC Output Voltage (High or Low State) (note 1) | -0.5 to $V_{CC} + 0.5$ | V |
| I_{IK} | DC Input Diode Current | - 50 | mA |
| I_{OK} | DC Output Diode Current (note 2) | ± 50 | mA |
| I_O | DC Output Current | ± 50 | mA |
| I_{CC} or I_{GND} | DC V_{CC} or Ground Current per Supply Pin | ± 100 | mA |
| P_D | Power Dissipation | 400 | mW |
| T_{stg} | Storage Temperature | -65 to +150 | $^{\circ}C$ |
| T_L | Lead Temperature (10 sec) | 300 | $^{\circ}C$ |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

- 1) I_O absolute maximum rating must be observed
 2) $V_O < GND$

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|------------------|---|---------------|-------------|
| V_{CC} | Supply Voltage (note 1) | 1.65 to 3.6 | V |
| V_I | Input Voltage | -0 to 3.6 | V |
| V_O | Output Voltage ($V_{CC} = 0V$) | 0 to 3.6 | V |
| V_O | Output Voltage (High or Low State) | 0 to V_{CC} | V |
| I_{OH}, I_{OL} | High or Low Level Output Current ($V_{CC} = 3.0$ to $3.6V$) | ± 24 | mA |
| I_{OH}, I_{OL} | High or Low Level Output Current ($V_{CC} = 2.3$ to $2.7V$) | ± 18 | mA |
| T_{op} | Operating Temperature | -40 to +85 | $^{\circ}C$ |
| dt/dv | Input Rise and Fall Time (note 2) | 0 to 10 | ns/V |

- 1) Truth Table guaranteed: 1.2V to 3.6V
 2) V_{IN} from 0.8V to 2V at $V_{CC} = 3.0V$

DC SPECIFICATIONS ($2.7V < V_{CC} \leq 3.6V$ unless otherwise specified)

| Symbol | Parameter | Test Condition | | Value | | Unit |
|----------------------|---------------------------------------|------------------------|---|----------------------|-------|------|
| | | V _{CC} (V) | | -40 to 85 °C | | |
| | | | | Min. | Max. | |
| V _{IH} | High Level Input Voltage | 2.7 to 3.6 | | 2.0 | | V |
| V _{IL} | Low Level Input Voltage | 2.7 to 3.6 | | | 0.8 | V |
| V _{OH} | High Level Output Voltage | 2.7 to 3.6 | I _O =-100 μA | V _{CC} -0.2 | | V |
| | | 2.7 | I _O =-12 mA | 2.2 | | |
| | | 3.0 | I _O =-18 mA | 2.4 | | |
| | | 3.0 | I _O =-24 mA | 2.2 | | |
| V _{OL} | Low Level Output Voltage | 2.7 to 3.6 | I _O =100 μA | | 0.2 | V |
| | | 2.7 | I _O =12 mA | | 0.4 | |
| | | 3.0 | I _O =18 mA | | 0.4 | |
| | | 3.0 | I _O =24 mA | | 0.55 | |
| I _I | Input Leakage Current | 2.7 to 3.6 | V _I = V _{CC} or GND | | ± 5 | μA |
| I _{I(HOLD)} | Input Hold Current | 3 | V _I = 0.8V | 75 | | μA |
| | | 3 | V _I = 2V | -75 | | |
| | | 3.6 | V _I = 0 to 3.6V | | ± 500 | |
| I _{OZ} | High Impedance Output Leakage Current | 2.7 to 3.6 | V _I = V _{IH} or V _{IL} V _O = 0 to 3.6V | | ± 10 | μA |
| I _{off} | Power Off Leakage Current | 0 | V _I or V _O = 0 to 3.6V | | 10 | μA |
| I _{CC} | Quiescent Supply Current | 3.6 | V _I = V _{CC} or GND | | 20 | μA |
| | | | V _I or V _O = V _{CC} to 3.6V | | ± 20 | |
| ΔI _{CC} | I _{CC} incr. per Input | 2.7 to 3.6 | V _{IH} = V _{CC} -0.6V | | 750 | μA |

DC SPECIFICATIONS ($2.3V < V_{CC} \leq 2.7V$ unless otherwise specified)

| Symbol | Parameter | Test Condition | | Value | | Unit |
|----------------------|---------------------------------------|------------------------|---|----------------------|------|------|
| | | V _{CC} (V) | | -40 to 85 °C | | |
| | | | | Min. | Max. | |
| V _{IH} | High Level Input Voltage | 2.3 to 2.7 | | 1.6 | | V |
| V _{IL} | Low Level Input Voltage | 2.3 to 2.7 | | | 0.7 | V |
| V _{OH} | High Level Output Voltage | 2.3 to 2.7 | I _O =-100 μA | V _{CC} -0.2 | | V |
| | | 2.3 | I _O =-6 mA | 2.0 | | |
| | | 2.3 | I _O =-12 mA | 1.8 | | |
| | | 2.3 | I _O =-18 mA | 1.7 | | |
| V _{OL} | Low Level Output Voltage | 2.3 to 2.7 | I _O =100 μA | | 0.2 | V |
| | | 2.3 | I _O =12 mA | | 0.4 | |
| | | 2.3 | I _O =18 mA | | 0.6 | |
| I _I | Input Leakage Current | 2.3 to 2.7 | V _I = V _{CC} or GND | | ± 5 | μA |
| I _{I(HOLD)} | Input Hold Current | 2.3 | V _I = 0.8V | 45 | | μA |
| | | 2.3 | V _I = 2V | -45 | | |
| I _{OZ} | High Impedance Output Leakage Current | 2.3 to 2.7 | V _I = V _{IH} or V _{IL} V _O = 0 to 5.5V | | ± 10 | μA |
| I _{off} | Power Off Leakage Current | 0 | V _I or V _O = 0 to 3.6V | | 10 | μA |
| I _{CC} | Quiescent Supply Current | 3.6 | V _I = V _{CC} or GND | | 20 | μA |
| | | | V _I or V _O = V _{CC} to 3.6V | | ± 20 | |

DYNAMIC SWITCHING CHARACTERISTICS (T_A = 25°C, Input t_r = t_f = 2.0ns, C_L = 30pF)

| Symbol | Parameter | Test Condition | | Value | | | Unit |
|------------------|--|------------------------|---|------------------------|------|------|------|
| | | V _{CC} (V) | | T _A = 25 °C | | | |
| | | | | Min. | Typ. | Max. | |
| V _{OLP} | Dynamic Peak Low Level Quiet Output (note 1, 3) | 2.5 | V _{IL} = 0V, V _{IH} = V _{CC} | | 0.6 | | V |
| | | 3.3 | | | 0.8 | | |
| V _{OLV} | Dynamic Valley Low Level Quiet Output (note 1, 3) | 2.5 | V _{IL} = 0V, V _{IH} = V _{CC} | | -0.6 | | V |
| | | 3.3 | | | -0.8 | | |
| V _{OHV} | Dynamic Valley High Level Quiet Output (note 2, 3) | 2.5 | V _{IL} = 0V, V _{IH} = V _{CC} | | 1.9 | | V |
| | | 3.3 | | | 2.2 | | |

- 1) Number of output defined as "n". Measured with "n-1" outputs switching from HIGH to LOW or LOW to HIGH. The remaining output is measured in the LOW state.
2) Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH to LOW or LOW to HIGH. The remaining output is measured in the HIGH state.
3) Parameters guaranteed by design.

AC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Condition | | Value | | Unit |
|--|--|------------------------|--|--------------|------|------|
| | | V _{CC} (V) | | -40 to 85 °C | | |
| | | | | Min. | Max. | |
| t _{PLH} t _{PHL} | Propagation Delay Time | 2.3 to 2.7 | | 1.0 | 3.2 | ns |
| | | 3.0 to 3.6 | | 0.8 | 2.5 | |
| t _{PZL} t _{PZH} | Output Enable Time | 2.3 to 2.7 | | 1.0 | 4.9 | ns |
| | | 3.0 to 3.6 | | 0.8 | 3.8 | |
| t _{PLZ} t _{PHZ} | Output Disable Time | 2.3 to 2.7 | | 1.0 | 4.2 | ns |
| | | 3.0 to 3.6 | | 0.8 | 3.7 | |
| t _{OSLH} t _{OSHL} | Output To Output Skew Time (note1, 2) | 2.7 to 3.6 | | | 0.5 | ns |
| | | 3.0 to 3.6 | | | 0.5 | |

1) Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW ($t_{OSLH} = |t_{PLHm} - t_{PLHn}|$, $t_{OSHL} = |t_{PHLm} - t_{PHLn}|$)

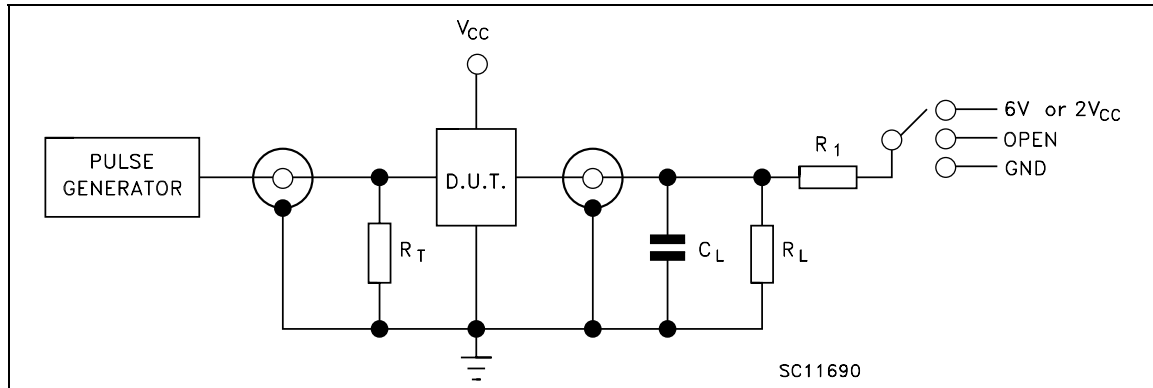
2) Parameter guaranteed by design

CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Test Condition | | Value | | | Unit |
|------------------|---|------------------------|---|------------------------|------|------|------|
| | | V _{CC} (V) | | T _A = 25 °C | | | |
| | | | | Min. | Typ. | Max. | |
| C _{IN} | Input Capacitance | 2.5 or 3.3 | V _I = 0V or V _{CC} | | 4 | | pF |
| C _{OUT} | Output Capacitance | 2.5 or 3.3 | V _I = 0V or V _{CC} | | 8 | | pF |
| C _{PD} | Power Dissipation Capacitance (note 1) | 2.5 or 3.3 | f _{IN} = 10MHz V _I = 0V or V _{CC} | | 28 | | pF |

1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/16$ (per circuit)

TEST CIRCUIT



| TEST | SWITCH |
|--|-----------|
| t_{PLH} , t_{PHL} | Open |
| t_{PZL} , t_{PLZ} ($V_{CC} = 3.0$ to $3.6V$) | 6V |
| t_{PZL} , t_{PLZ} ($V_{CC} = 2.3$ to $2.7V$) | $2V_{CC}$ |
| t_{PZH} , t_{PHZ} | GND |

$C_L = 30$ pF or equivalent (includes jig and probe capacitance)

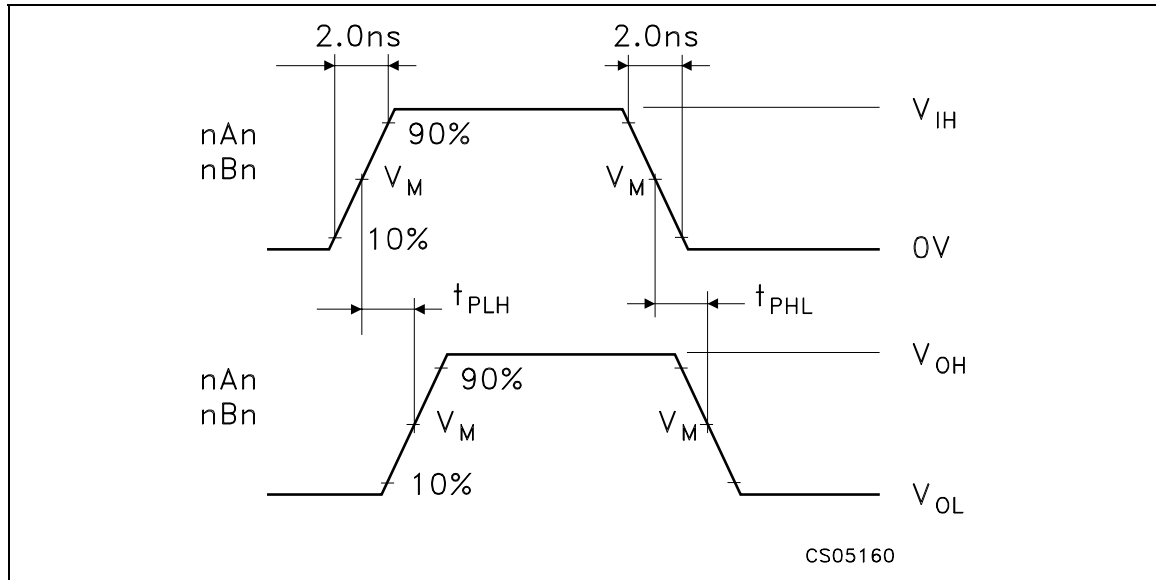
$R_L = R_1 = 500\Omega$ or equivalent

$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

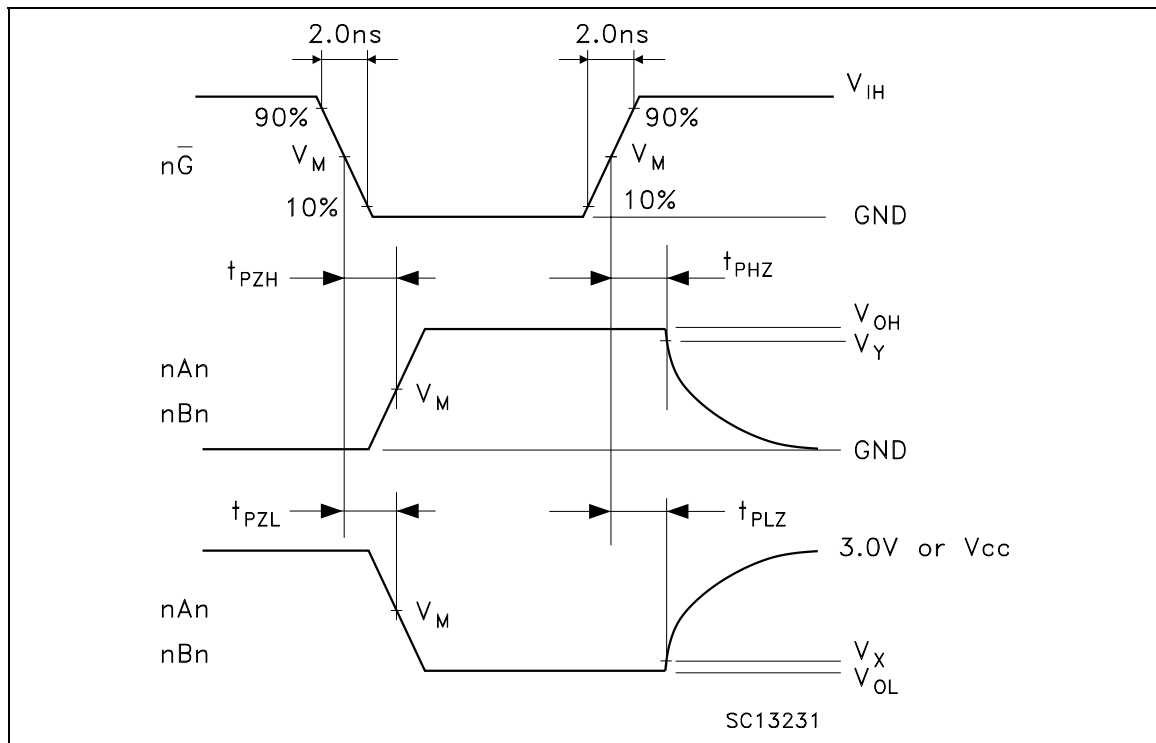
WAVEFORM SYMBOL VALUE

| Symbol | V_{CC} | |
|----------|-----------------|------------------|
| | 3.0 to 3.6V | 2.3 to 2.7V |
| V_{IH} | 2.7V | V_{CC} |
| V_M | 1.5V | $V_{CC}/2$ |
| V_X | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ |
| V_Y | $V_{OL} - 0.3V$ | $V_{OL} - 0.15V$ |

WAVEFORM 1: PROPAGATION DELAY (f=1MHz; 50% duty cycle)

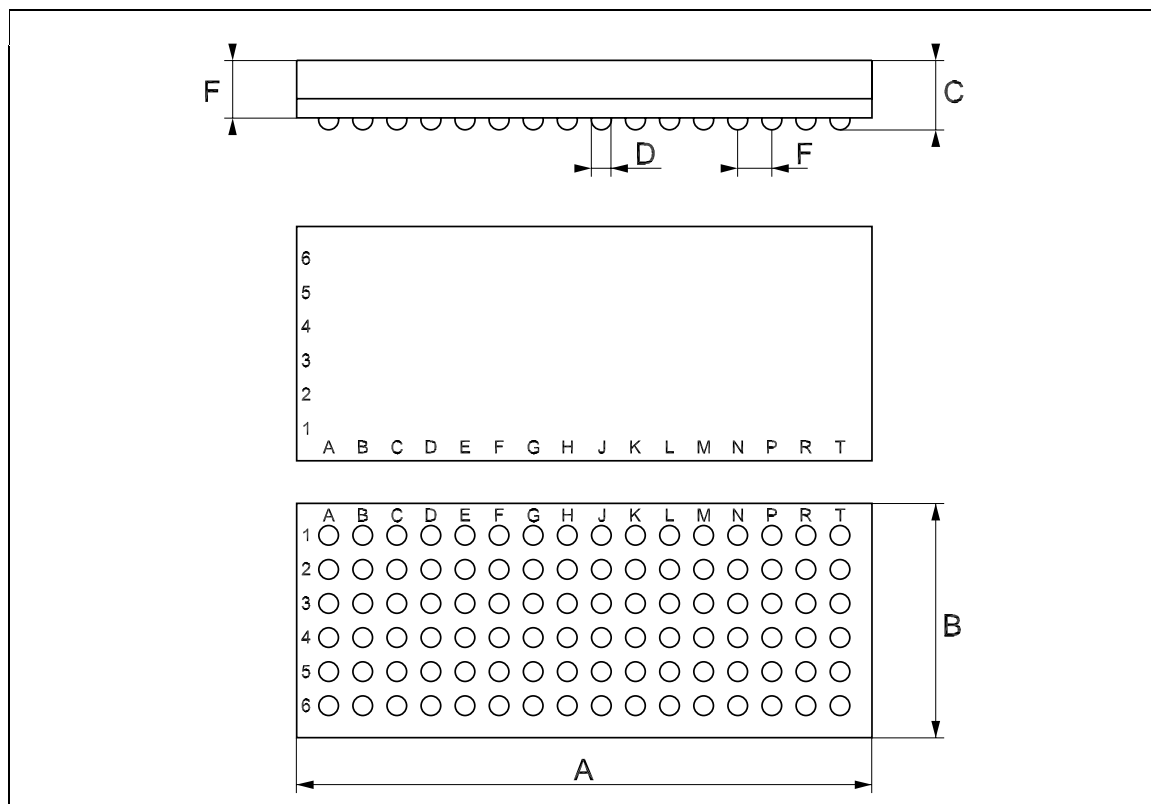


WAVEFORM 2: OUTPUT ENABLE AND DISABLE TIME (f=1MHz; 50% duty cycle)



LFBGA96 MECHANICAL DATA

| DIM. | mm. | | | mils | | |
|------|-------|-----|-------|-------|------|-------|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 13.40 | | 13.60 | 527.5 | | 535.4 |
| B | 5.40 | | 5.60 | 212.6 | | 220.5 |
| C | | | 1.6 | | | 63.0 |
| D | | | 0.5 | | | 19.7 |
| E | | 0.8 | | | 31.5 | |
| F | 0.85 | | 0.95 | 33.5 | | 37.4 |



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